

21 to p. 4, line 4. Therefore the amendment does not add new matter to the claims. The Applicants have particularly pointed out and distinctly claimed the subject matter that they regard as their invention. Therefore, Applicants request that the Examiner withdraw the rejection of claims

12, 14, 15, and 17 under 35 U.S.C. § 112, second paragraph, and allow the claims to issue.

The Examiner notes that the application names joint inventors and advises the Applicants of the obligation under 37 C.F.R. § 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made. The Examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made. The Applicants confirm that each claim was commonly owned at the time the invention was made.

The Examiner rejected claims 1, 2, 4, 5, 7, 8, 10, 11, 13, and 16 under 35 U.S.C. § 103(a) as being unpatentable over Nakayoshi because Nakayoshi discloses an adhesive composition for bonding a semiconductor chip to an attachment member for the chip comprising a curable polymer composition comprising from 1000 to 1,000,000 weight-ppm spherical filler having an average particle size of from 10 to 100 micrometers and a major axis-to-minor axis ratio of from 1 to 1.5. The Examiner further argues that Nakayoshi discloses that the curable polymer composition can be a curable silicone composition, such as an addition reaction-curable silicone composition. Nakayoshi discloses a semiconductor device comprising a semiconductor chip bonded to an attachment member for the chip by the adhesive composition. The Examiner admits that Nakayoshi does not disclose the polymer composition comprising from 1 to 900 weight-ppm spherical filler. The Examiner further argues that Nakayoshi discloses that in a process of manufacturing the adhesive, filler weight-ppm is a result-effective variable. The Examiner concludes that it would have been an obvious matter of design choice ascertainable by routine experimentation to choose the particular claimed filler weight-ppm limitation.

Nakayoshi discloses an adhesive for joining a semiconductor pellet to a semiconductor pellet attachment member, composed of (A) an organopolysiloxane having at least two silicon-bonded alkenyl groups per molecule, (B) an organopolysiloxane having at least two silicon-bonded hydrogen atoms per molecule, (C) an organosilicon compound having a silicon-bonded alkoxy group, (D) an organic or inorganic spherical filler whose particle diameter is 10 to 100 micrometers and whose major/minor axis ratio is 1.0 to 1.5, and (E) a catalytic amount of platinum or a platinum compound (Abstract). The adhesive contains 100 weight parts of component (A). The adhesive

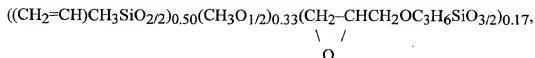
contains an amount of component (B) such that there will be 0.5 to 3 mol of silicon-bonded hydrogen atoms in component (B) per mole of silicon bonded alkenyl groups in component (A). The adhesive contains 0 to 10 weight parts of component (C), and 0.1 to 100 weight parts of component (D) (paragraph 6). Nakayoshi discloses that the amount in which component (D) is contained must be between 0.1 and 100 weight parts per 100 weight parts of component (A). If component (D) is contained in an amount less than 0.1 weight part per 100 weight parts of component (A), there will be a pronounced loss of wire bondability to the semiconductor pellet after the semiconductor pellet and the semiconductor pellet attachment member have been joined by the adhesive (paragraph 21). Nakayoshi does not teach or suggest any curable epoxy resin compositions, curable acrylic resin compositions, or curable polyimide resin compositions in the adhesive. Nakayoshi does not teach or suggest any curable epoxy-modified silicone compositions, curable acrylic-modified silicone compositions, or curable polyimide-modified silicone compositions in the adhesive. Nakayoshi further discloses a semiconductor device characterized in that a semiconductor pellet and a semiconductor pellet attachment member are joined by the cured product of said adhesive (paragraph 7).

This invention relates to an adhesive composition for bonding a semiconductor chip to an attachment member for the chip comprising a curable polymer composition comprising from 1 to 900 weight-ppm spherical filler having an average particle size of from 10 to 100  $\mu\text{m}$  and a major axis-to-minor axis ratio of from 1 to 1.5. This invention further relates to semiconductor devices characterized in that a semiconductor chip is bonded to a mounting component thereof by the adhesive (p. 3, line 21 to p. 4, line 4). The spherical filler content in the adhesive is from 1 to 900 weight-ppm based on the weight of the curable polymer composition (p. 5, lines 6-9). It becomes increasingly difficult to obtain a constant chip-to-mounting component gap when the spherical filler content in the adhesive falls below the above-specified lower limit (p. 5, lines 9-11). At the other extreme, an inability to thoroughly relax the mechanical stresses acting on the semiconductor chip becomes increasingly prominent when the above-specified upper limit is exceeded (p. 5, lines 11-13).

One skilled in the art would not be have a reasonable expectation of success to arrive at this invention based on the disclosure of Nakayoshi. Nakayoshi teaches away from this invention because Nakayoshi teaches that to use an amount of filler less than 1000 weight ppm (0.1 weight %) causes a detriment (pronounced loss of wire bondability, as discussed above). One skilled in the art

would not be motivated to use less than 1000 weight ppm of filler because if the filler is contained in an amount less than 0.1 weight part per 100 weight parts of component A, there will be a pronounced loss of wire bondability to the semiconductor pellet after the semiconductor pellet and the semiconductor pellet attachment member have been joined by the adhesive containing the filler. Therefore, one skilled in the art would not be motivated to use an amount of filler less than 1000 weight ppm based on the disclosure of Nakayoshi.

Furthermore, this invention provides unexpected results over the disclosure of Nakayoshi. Example 1 and Comparative Example 2 illustrate the unexpected results. In Example 1, an adhesive was prepared by mixing the following to homogeneity: 100 weight parts dimethylvinylsiloxyl-endblocked dimethylpolysiloxane, 1.5 weight parts trimethylsiloxyl-endblocked methylhydrogenpolysiloxane, 1 weight part organopolysiloxane with the average unit formula



0.1 weight part of a 1 weight% isopropanolic chloroplatinic acid solution, 0.05 weight part (this addition gave 500 weight-ppm in the adhesive) of a spherical silica micropowder with an average particle size of 40  $\mu\text{m}$  (standard deviation on the particle size distribution = 3  $\mu\text{m}$ ) and an aspect ratio of 1.05, 0.01 weight part 3-phenyl-1-butyn-3-ol, and 2 weight parts fumed silica (average particle size = 30  $\mu\text{m}$ , BET specific surface area = 200  $\text{m}^2/\text{g}$ ) whose surface had been treated with hexamethyldisilazane. When heated for 30 minutes at 150°C, this adhesive produced a silicone rubber that gave a value of 30 for the type A durometer specified in JIS K-6253. Semiconductor devices were fabricated using the adhesive, and after 3,000 cycles, the defect rate was 0%.

In Comparative Example 2, an adhesive was prepared as in Example 1, but in this case using 157 weight parts (this addition corresponded to 60 weight% in the adhesive) of the spherical silica micropowder that was employed in Example 1. When heated for 30 minutes at 150°C, this adhesive produced a silicone rubber that gave a value of 48 for the type A durometer specified in JIS K-6253. Semiconductor devices were fabricated using the adhesive, and after 3,000 cycles, the defect rate rose to 55%.

This invention is not obvious over Nakayoshi because Nakayoshi teaches away from this invention and the amount of filler disclosed in this invention provides unexpected results over

Nakayoshi. The Applicants request that the Examiner withdraw rejection of claims 1, 2, 4, 5, 7, 8, 10, 11, 13, and 16 under 35 U.S.C. § 103(a) and allow the claims to issue.

The Examiner rejected claims 1, 2, 4, 5, 7, 8, 10, 11, 13, and 16 under 35 U.S.C. § 103(a) as being unpatentable over Nakayoshi in view of Sierawski for the reasons discussed above for Nakayoshi and because Sierawski discloses that an adhesive polymer composition comprising less than about 20 weight percent filler. The Examiner further argues that it would have been obvious to combine the product of Sierawski with the product of Nakayoshi because it would provide a filler.

The disclosures of Nakayoshi and this invention are as discussed above. Sierawski discloses a curable organosiloxane composition comprising (A) a polyorganosiloxane containing at least two alkenyl radicals per molecule, (B) an amount sufficient to cure said composition of an organohydrogensiloxane containing at least two silicon-bonded hydrogen atoms per molecule, where the sum of the alkenyl radicals per molecule of (A) and the silicon-bonded hydrogen atoms per molecule of (B) is greater than 4, (C) an amount sufficient to promote curing of said composition of a hydrosilation catalyst, and (D) an amount sufficient to impart adhesion to cured articles prepared from said composition of 1) an epoxide compound, 2) an organosilicon compound, 3) a chelated aluminum compound derived from a 1,3-diketone; and (E) an amount sufficient to impart flame retardancy to said composition of an additive comprising at least one compound selected from the group consisting of hydrated aluminum oxide and magnesium hydroxide (col. 2, line 60 to col. 3, line 18). Sierawski discloses that fillers such as silica can be added to the composition (col. 8, lines 52-59). Sierawski discloses that compositions containing less than about 20 weight percent of fillers are particularly useful as adhesives (col. 10, lines 34-40).

One skilled in the art would not be motivated to combine the disclosures of Nakayoshi and Sierawski. Nakayoshi requires that component (D) must be spherical; the major/minor axis ratio of component (D) must be between 1.0 and 1.5 (paragraph 20). Based on the disclosure of Sierawski, one skilled in the art would not know which, if any, fillers would be suitable to use in the composition of Nakayoshi. Silica is the only filler exemplified by Sierawski (col. 8, lines 52-67).

In Example 2 of Nakayoshi, a curable composition is prepared containing 1.1 weight parts of polystyrene beads with a diameter of 20 micrometers (standard deviation of bead diameter distribution: 1.2 micrometers) and a major/minor axis ratio of 1.06. A semiconductor device produced using the cured product of the composition as adhesive had a malfunction rate of 0/50. In Comparative Example 2 of Nakayoshi, a composition was prepared as in Example 1 except that 15

weight parts of amorphous silica fines with a particle diameter of 40 micrometers and a particle diameter distribution of 3 to 100 micrometers was used instead of the polystyrene beads. A semiconductor device produced using the cured product of the composition as adhesive had a malfunction rate of 50/50. Silica is the only filler exemplified by Sierawski (col. 8, lines 52-67). Finely divided forms of silica are preferred by Sierawski (col. 8, lines 60-61). Therefore, Nakayoshi teaches away from Sierawski.

The Patent Office must identify where the prior art provides a motivating suggestion to make the necessary modifications (In re Jones, 21 U.S.P.Q. 2d 1941, Fed. Cir. 1992). The Examiner argues that it would have been obvious to combine the product of Sierawski with the product of Nakayoshi because it would provide a filler. However, the mere fact that the prior art may be modified as suggested by the Examiner does not make the modification obvious unless the prior art suggests the desirability of the modification (In re Fritch, 23 U.S.P.Q. 2d 1780, Fed. Cir. 1992). Here, Nakayoshi already discloses a filler with specific properties, as discussed above. This filler provides specific benefits, including preserving wire bondability of a semiconductor pellet after the semiconductor pellet has been joined to a semiconductor pellet attachment member (para graph 20). One skilled in the art would not be motivated to remove component (D) of Nakayoshi and replace it with a filler of Sierawski because nothing in the disclosure of Sierawski teaches or suggests that this would provide a benefit over the filler already disclosed by Nakayoshi as component (D). Nothing in the disclosure of Sierawski teaches or suggests that removing the required component (D) of Nakayoshi and replacing it with a filler of Sierawski would improve preserving wire bondability of a semiconductor pellet after the semiconductor pellet has been joined to a semiconductor pellet attachment member. Furthermore, Example 2 and Comparative Example 2 of Nakayoshi suggest that removing required component (D) and replacing it with another filler such as the silica disclosed by Sierawski would be destroy a benefit provided by component (D).

Furthermore, even if one skilled in the art did combine the disclosures of Nakayoshi and Sierawski, this would not provide a reasonable expectation of success to arrive at this invention because the adhesive composition of this invention comprises a curable polymer composition comprising and from 1 to 900 weight-ppm spherical filler. The spherical filler has an average particle size of from 10 to 100  $\mu\text{m}$  and a major axis-to-minor axis ratio of from 1 to 1.5. This invention further relates to semiconductor devices. Sierawski does not teach or suggest the particle size range of the filler. In contrast, in this invention the average particle size of this spherical filler

should be between 10 and 100  $\mu\text{m}$ . The basis for this range is as follows. The generation of a constant gap between the semiconductor chip and its mounting component becomes highly problematic in the case of adhesive that uses spherical filler with an average particle size below 10  $\mu\text{m}$ . At the other extreme, the use of spherical filler with an average particle size exceeding 100  $\mu\text{m}$  is undesirable when the generation of an overly large chip-to-mounting component gap is undesirable (p.4, lines 5-13). Sierawski does not teach or suggest the major axis-to-minor axis ratio of from 1 to 1.5. In contrast, in this invention the aspect ratio of the spherical filler under consideration is within the range from 1 to 1.5. It becomes increasingly difficult to generate a constant chip-to-mounting component gap in the case of adhesive that uses spherical filler whose aspect ratio exceeds the given upper limit (p. 4, lines 13-17). Sierawski does not teach or suggest that the adhesive contains 1 to 900 weight-ppm spherical filler. In contrast, this in this invention it becomes increasingly difficult to obtain a constant chip-to-mounting component gap when the spherical filler content in the adhesive falls below the above-specified lower limit. At the other extreme, an inability to thoroughly relax the mechanical stresses acting on the semiconductor chip becomes increasingly prominent when the above-specified upper limit is exceeded (p. 5, lines 6-13).

One skilled in the art would not have a reasonable expectation of success to arrive at this invention based on the disclosures of Nakayoshi and Sierawski because Nakayoshi teaches away from this invention, as discussed above, there is no motivation to combine the disclosures of Nakayoshi and Sierawski, and one skilled in the art would not have a reasonable expectation of success to arrive at this invention by replacing the filler of Nakayoshi with the filler of Sierawski, as discussed above. Therefore, the present invention is not obvious over Nakayoshi in view of Sierawski. The Applicants request that the Examiner withdraw rejection of claims 1, 2, 4, 5, 7, 8, 10, 11, 13, and 16 under 35 U.S.C. § 103(a) and allow the claims to issue.

The Examiner rejected claims 6 and 9 under 35 U.S.C. § 103(a) as being unpatentable over Nakayoshi in view of Sierawski for the reasons discussed above for claim 1 and because Sierawski discloses a curable polymer composition that is a curable epoxy resin composition comprising a filler with a specific surface area. The Examiner further argues that The Examiner concludes that it would have been obvious to combine the product of Sierawski with the product of Nakayoshi because it would provide a polymer composition and a filler.

This invention is not obvious over Nakayoshi in view of Sierawski for the reasons discussed above for claims 1, 2, 4, 5, 7, 8, 10, 11, 13, and 16, and therefore this rejection is moot. The

Applicants request that the Examiner withdraw rejection of claims 6 and 9 under 35 U.S.C. § 103(a) and allow the claims to issue.

The applicants have particularly pointed out and distinctly claimed the subject matter that they regard as their invention, and the instant invention is novel and unobvious. Reconsideration of the application is requested.

The present response is being submitted within the three month response period for response to the outstanding office action. Although the applicants believe in good faith that no extensions of time are needed, the applicants hereby petition for any necessary extensions of time. You are authorized to charge deposit account 04-1520 for any fees necessary to maintain the pendency of this application.

Respectfully Submitted,  
DOW CORNING CORPORATION



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